The Philippine "Tamarao."

IN 1878 I reported in a letter to Dr. Sclater, the existence of a species of *Anoa* in the Island of Mindoro, on the strength of an example of the *Tamarao* labelled *Anoa depressicornis* in a Museum at Manilla. Having since seen living specimens of the Celebean *Anoa*, I have no hesitation in affirming that the latter animal has not even a superficial resemblance to the *Tamarao* which I saw at Manilla. I have now no doubt that the *Tamarao* of the Manilla Museum is a buffalo,—not, however, an immature example of the common buffalo, as has been suggested, but a distinct species, with short flattened horns sloping directly backwards. A. H. EVERETT.

41 York Terrace, Regent's Park.

A Pheasant attacking a Gamekeeper.

As the keeper was walking home, a distance of half a mile, through the plantations near his cottage, a pheasant flew at him three times, attacking his legs in a most savage manner. The keeper got to his cottage with the pheasant after him, and called his wife out to witness the incident.

The keeper was able to secure the pheasant and return it to the cover. I should be glad to know if such conduct is exceptional on the part of game birds. M. H. MAW.

Walk House, Barrow, Hull, November 30.

THE MORPHOLOGY OF BIRDS.[1]

I.

THIS magnificent work, consisting of two folio volumes, with more than 1700 pages of closely printed text, and illustrated by more than thirty artistically executed plates, is the latest of the "Bijdragen tot de Dierkunde" ("Contributions to the Knowledge of Animals"), published by the Royal Zoological Society, *Natura Artis Magistra*, of Amsterdam, on its fiftieth anniversary. It is the parting gift to that Society of its grateful author, who, one of Prof. Gegenbaur's ablest pupils, now fills the Chair of Anatomy in the University of Jena; and it is needless to say that the publication of so monumental a work reflects the highest credit upon the Society of Amsterdam. It is monumental not merely from its bulk, but chiefly from the enormous amount of information it contains, much of it bearing upon some of the most deeply-rooted questions of importance to the general morphologist, and above all on the natural affinities—that is to say, the phylogeny—of birds both living and extinct.

In what follows I make no attempt at a critical review, but give as complete a summary as possible of Prof. Fuerbringer's work, which I trust will be acceptable to English readers, for few of them will have the opportunity of seeing these costly and weighty volumes, or the perseverance to master their contents, and yet it cannot be but that many would like to know the results at which the author's investigations have led him to arrive.

The whole work consists of two parts.

The special part comprises the first 837 pages, and is devoted to a minute and most comprehensive description of the bones, nerves, and muscles of the avian shoulder-girdle in the widest sense. The investigations extend over many hundreds of birds of all orders and families; frequently numerous specimens of the same species have been examined in order to ascertain the extent of individual variability.

The author justly asks himself if it is not too much to offer such a bewildering mass of mere detail to the public; but he considers it indispensable that the reader, who may not easily yield acceptance to the generalizations, should be offered the fullest opportunity to re-examine the facts in detail, and to follow step by step the road which has led the author to his conclusions.

At the same time, it must be borne in mind that the first part of the work is not merely descriptive, but that it contains a series of complete essays on the morphology of the organs under consideration. The treatment of the structure, development, and modifications of the sternum, for instance, takes up not less than 78 pages. In the myological part particular attention has been bestowed upon the proper naming and homologizing of the muscles.

The descriptive detail deposited in the special part has been used in the *second or generalizing part* as the material for reflections. These lead (*a*) to morphological results, which are important chiefly for the phylogenesis of the skeletal, nervous, and muscular systems; (*b*) they form a basis for a new systematic arrangement of birds. Physiological questions are less dwelt upon, but there are numerous contemplations on the theory of flight, and a remarkable chapter on cold- and warm-bloodedness.

The author remarks that the study of the morphology of birds well repays the labour bestowed upon it, not so much because of the great or fundamental variety which this class of vertebrates exhibits, but rather because several organic systems have reached a height of development which they have not attained in any other class of animals. We often find a richness of organic differentiations within the limits of small groups of birds. It is therefore possible to form a judgment, approaching almost to certainty, as to the primary or secondary significance of these differences. It is interesting to follow the steps which lead to such astonishing heights of specialization.

Pp. 839–996 are devoted to results and reflections of general morphological importance. For instance, the changes in the configuration of the sternum which are brought about by the modifications of the muscles of the pectoral girdle. There is not unfrequently an apparent discord between the passive or skeletal and the active or muscular elements; of these the latter are by far the more progressive, so that the more conservative skeletal parts have not always kept step with the newly introduced changes of the muscles. An example of this is afforded by the wings. By the reduction of the wing, beginning at the distal end, those muscles are first affected which arise from the wing bones, next are affected the bones themselves, and lastly those muscles which are inserted on the same (p. 855).

Syndesmology receives much attention, chiefly by an extensive treatment of the shoulder-joint. Joints are certainly not formed by the action of the muscles during embryonic life, but they are phylogenetically preformed, and only during the post-embryonic stages can the finer configuration of the joints be modelled and influenced by the muscles.

P. 862.—Questions of the greatest importance are involved in the transformation of mere ligamentous connections into symphyses and joints, with the accompanying neoblastic appearance of cartilage. This new cartilage is either homoblastic or heteroblastic. It arises from latent cartilaginous cells, as is the case with the addition of new vertebræ at the end of the Ophidian tail, and probably with the multiplication of the Cetacean phalanges; or the cartilage is due to transformation of periosteal cells, like the patella ulnaris. In such cases the original ligament can be supplanted by bone. On the other hand, the clavicle is sometimes transformed into a ligamentum claviculare.

Fasciæ are often strengthened into aponeuroses and into tendons; they are used as such, not only by their own muscle, but also by neighbouring ones, and this leads to the formation of paratenons or tendinous slips. Birds afford numerous instances in which muscles have gained extra support by "anchoring" themselves to neighbouring fasciæ.

Pp. 877–82 treat of *sesamoid* bodies, of which the author recognizes three sorts. (1) Skeletogenous sesamoids, like the pisiform bone, are, strictly speaking, not sesamoids, as they are retrograded skeletal parts, which in most cases have been preserved by the surrounding muscles. (2) Arthrogenous sesamoids, like the os humero-scapulare, are derived from the capsule of a joint. (3) Tenontogenous or desmogenous, like the patella, are formed heteroblastically inside of a tendon.

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[1] "Untersuchungen zur Morphologie und Systematik der Voegel, zugleich ein Beitrag zur Anatomie der Stuetz- und Bewegungsorgane." Von Max Fuerbringer, Professor der Anatomie, und Direktor des anatomischen Institutes und des Museum Vrolik der Universitaet zu Amsterdam. Mit 30 Tafeln. (Amsterdam: T. van Holkema, 1888.)

The eighth and ninth chapters (pp. 894–947), form a critical essay on muscles with regard to their connection with the nervous system. After having exhaustively criticized the neuro-muscle theory of Kleinenberg, the various views of Huxley, those of the brothers Hertwig with reference to the cœlom theory, and, lastly, the theory of the secondary connection of muscle- and nerve-fibres as promulgated by Claus and Chun, the author considers the ontogeny, degeneration, and regeneration of muscles and nerves. Lastly, he proceeds to attempt a decision (pp. 920–41).

In connection with this attempt stands a discussion of the inheritance of acquired faculties, and the continuity of germinal and somatic plasma. Fuerbringer believes in Haeckel's law of accumulative adaptation through inheritance. What the individual has acquired during and through its incessant contact with the world can greatly influence its descendants; hence the great importance of the investigation of post-embryonic developmental changes. Throughout the whole book, Fuerbringer, without denying the importance of the ontogenetic features as a recapitulation of the ancestral history, lays more stress upon the study and comparison of the adult forms. In almost every chapter, we come across instances in which the embryonic development does not help to explain certain organs; the recapitulation of their previous stages is too much hurried or condensed, and at the best only that is repeated which had last been acquired.

Fuerbringer accepts Kleinenberg's neuro-muscle theory as the most probable solution. The whole apparatus, which consists of a ganglionic cell, a nervous and a muscular fibre, has been developed from one and the same cell, and is therefore to be looked upon as one organ. The muscle is the end-organ of its nerve, consequently the innervation of the muscles forms the most trustworthy means for the determination of their homologies.

Chapter x. (pp. 947–72) deals with the variability of muscles. Neither the point of the origin, nor that of the insertion, of muscles is a safe guide to their homologies. This shows why muscles are almost valueless for the determination of the homologies of skeletal parts.

Pp. 972–91, on the shifting or migration of the extremities with their girdles along the vertebral axis. This shifting has reached its highest degree in birds. Even individual and one-sided variations are frequent. As a rule, the shifting has been directed backwards, resulting in an increase of the length of the neck. Large birds show a greater amount of shifting than the smaller ones of the same family. A retrograde or secondary shifting towards the head seems to stand in correlation with the degradation of the wings. Hand in hand with the changes of the relative position of the limb and girdle goes a change of the whole thorax. Thoracic vertebræ are turned into cervical, and lumbar into thoracic vertebræ. In most cases, but not always, the number of thoracic ribs remains the same. It looks as if, roughly speaking, the whole trunk with all the organs inclosed in it, did slide along the vertebral axis. The accompanying metamerical transformation of the plexus brachialis is not effected by inter- or excalation of nervous segments, but by the diminution and reduction of one anterior nerve-stem, and the contemporary formation and addition of a nerve nearer to the posterior end of the plexus. The peripheral parts of the plexus retain their configuration in spite of all the changes, and since the only trustworthy safeguard in the homologies of spinal nerves is their number in the series of metameres, two plexuses may be homodynamous, although, strictly speaking, not homologous. This is expressed by the term "imitatory homodynamy," more happily by "parhomology."

The same considerations apply to the muscles. They, together with the nerves, undergo metameric changes until they likewise are only parhomologous. The various muscles of the shoulder-girdle of a bird with thirteen cervical vertebræ may present, in shape, position, and distribution of the nerves, features identical with those of a bird with fifteen cervical vertebræ, but still they are only parhomologous to each other.

This metameric transformation cannot, of course, be watched on those muscles which arise from the shoulder-girdle, but on those which, like the mm. rhomboidales et serrati, arise from the trunk, and are inserted into the girdle. The migration of the whole anterior extremity tailwards necessitates first elongation, then a thinning out, and even total reduction, of those muscles which extended from the neck to the anterior end of the shoulder-girdle. In this way the m. levator scapulæ of the reptiles has become lost by the birds.

Of course the whole problem of the metameric transformation and new formation of muscles and nerves cannot be considered as solved without an explanation of the histological changes which are involved in the question of the parhomology of the muscles together with their nerves. Such an explanation Fuerbringer has not been able to present, but he tries to suggest one by showing how we may imagine those changes to take place.

Most muscles, Fuerbringer argues, are polymetameric, *i.e.* they receive nervous fibres from two or more spinal roots. Moreover, the nerves of the more proximal muscles belong chiefly to the pre-axial or anterior, whilst those of the distal or more peripheral muscles receive their nerves mostly from the post-axial roots of the plexus. The author discards the idea that nerve-fibres can send out buddings into neighbouring new muscles, but thinks that in many cases the formation of new muscles and nerve-fibres is initiated by a splitting. This splitting begins peripherally with the muscle-fibre, is followed by that of the nerve-fibre, and perhaps leads to a division of the ganglionic cell. Ganglionic cells with two axial cylinders of motory nerves are known to occur.

Another possible explanation of the increase of the number of fibres of one nerve and those of one muscle is their derivation from cells which had remained latent in an embryonic or primordial condition between the fully formed muscle- and nerve-cells. Traces of such primordial elements Fuerbringer has found between the fibres of motory nerves, and between the fibres of fully developed muscles; in the latter case they may be identical with the myoblasts of other authors.

Everywhere in nature, in the organism, there is superfluity of material. Tissues and organs seem to be trained by the struggle for existence in such a way that they produce at their beginning an abundance of formative germs and cells, of which under ordinary circumstances only a small part becomes developed into specifically functional tissue-cells. The rest remain in their primitive embryonic condition. They form stored-up plastic material, which may or may not be called upon to meet such extraordinary requirements as may arise from the necessity for the organism to adapt itself to new conditions.

Still greater is the difficulty when the neomorphism (by which word the reviewer has on a previous occasion tried to render into English the meaning of the German term "*Neubildung*,"—new formation not being exactly identical with it) is not confined to the same, but takes place in the next following metamere. For instance, when a muscle, which previously was innervated by the fibres from the 15th and 16th spinal nerves, now receives its supply from the 15th, 16th, and 17th nerves, the explanation given above will be of no avail. The permanent continuity of the two later components of the original neuro-muscle cells forbids the assumption of a secondary junction; in our case the junction of fibres of the 17th spinal nerve with those fibres of the old muscle which, by migration or by increase in number, have come to be situated on the 17th metamere.

Fuerbringer explains these changes by an ingenious hypothesis, viz. by a peculiar mode of growth, which he terms "growth by metameric opposition or reduction of the muscles and nerves." The primordial extremity was perhaps somewhat broader, and extended over a greater number of metameres. This surplus of locomotory elements was reduced by the following concentration of the limb, but not so completely that those metameres did not in later generations retain *vi inertiæ* the faculty of reproducing some of the nearly lost elements in a primitive condition. The reduction of these germs, that are not called upon, would become complete, they would be lost, but for the particular stimulus which they and their metameres receive from the extremity. The real nature of the interdependence between a stimulus and its effect is still an obscure problem; but we can imagine that the shifting limb exercised a stimulating influence upon the newly overlaid metameres, and that this stimulus awakened the latent nerve-muscle germs, which then joined the already existing apparatus of the approaching limb. Such latent germs, when once started into activity, may well be required to fully develop in order to make up for the reduction of the motory elements at the opposite end of the limb. As a support for this speculation, Fuerbringer alludes to the fact that the anterior limb of birds now tends to shift backwards, and it is the last root of the brachial plexus which contains relatively the greatest number of those immeasurably fine elements that he is inclined to consider as latent germs. The absolutely gradual mode of growth, which this metameric apparition postulates, makes it less perplexing that parts which are only parhomologous should be the very counterfeits of each other.

Pp. 984–91. What has caused the backward shifting of the anterior extremity? To inquire into the causation of the length of the neck means the same problem in a different form. A correlation between the length of the neck and that of the legs is not always there, *e.g.* swans. The assumption of intercalation of vertebræ is still unjustifiable, being quite unsupported by proofs. There remain lengthening of the single vertebræ and the shifting of the extremity along the axis.

In stretching our neck, we bring into play chiefly two sets of muscles, viz. the extensors of the neck and the depressors of the shoulder and anterior limb. There is no reason for assuming that the ancestors of recent birds did not effect the stretching of their necks in the same way. Continued habit results in permanent conditions. In a well-extended neck the vertebræ are in more perfect equilibrium and in conditions more favourable to their nutrition and growth than if the neck were much curved and doubled up. The pectoral girdle, the sternum, and the whole anterior limb of birds are *in toto* retracted by the incessant pulling of the mm. rhomboides, serrati, latissimus dorsi, and the abdominal muscles, the latter so far as they are attached to the sternum. Many of the thoracic muscles show a pronounced tendency to extend their origin tailwards. As a rule, large birds possess more cervical vertebræ than smaller birds, and they are noteworthy for their soaring and more lasting mode of flight. During the time that the wings are not moved, but are kept in a spread-out position, they offer a greater resistance to the air than the far smaller but heavier bulk of the body. The momentum gained by the body will therefore tend to move the latter forwards with more velocity than the resisting wings. In other words, the wings will remain behind the body, and the strain produced by this difference in equilibrium will act upon the ribs, since these form the weakest connection of the sternum + shoulder-girdle + wing with the rest of the body. The anterior thoracic ribs will lose their sterno-costal character, and be transformed into cervical ribs, *i.e.* the neck is lengthened, and the whole pectoral girdle, with the whole apparatus of flight, will be shifted backwards. The reduction of thoracic into cervical ribs can be proved on grounds independent of this question. The long necks of the Ratite birds seem to offer a serious objection to the view just explained, but Fuerbringer pleads in another part of his work (p. 1504) for their being descendants of birds which possessed well-developed power of flight.

Pp. 991–95 contain some remarkable observations about the size of birds. On the whole, small birds show more primitive and simpler conditions of structure, whilst the larger members of the same group exhibit a more one-sided development, and consequently greater deviation from the common stock. The first birds were probably smaller than Archæopteryx. Reptiles and mammals show likewise in their earlier and smaller types more primitive features than do their larger descendants. It is therefore the study of the smaller members within given groups of animals which promises the best results as to their phylogeny.

H. GADOW.

(*To be continued.*)

STATISTICS OF THE BRITISH ASSOCIATION.

IT may prove instructive to see, in diagram-form, some statistics connected with the history of the British Association. We go back only to 1850 (the Association, it is known, dates from 1831), and our curves relate to the total attendance in each year to the present, to attendance of ladies, and to grants in aid of scientific research.

As regards attendance, it will be seen that the maximum is that of the Manchester meeting in 1887, the figure 3838 having been then reached. Newcastle, in 1863, comes next, with 3335; then Manchester again, in 1861, with 3133. The curve reaches high points also in the case of Liverpool in 1870, Glasgow in 1876, Southport in 1883, &c.

On the other hand, we find the curve reaching its lowest, in this period, at Ipswich, in 1851, with 710; while Hull, in 1853, Swansea in 1880, Cheltenham in 1856, Cambridge in 1862, and Plymouth in 1877, furnish other low points, in rising series.

The general course of the curve seems to be that of rise to a maximum at Newcastle in 1863, then descent to Swansea in 1880, followed by another rise to the peak representing Manchester in 1887. The meeting at Montreal (in 1884) it will be seen, takes a fairly good position as to numbers (1777).

Several places had a second visit *in the period considered* (not necessarily second in the whole series); these are indicated by figures after the abbreviated names. How do those repeated visits compare with the earlier? In general, the second visit considerably exceeds the first in numbers. But in the case of Aberdeen the second figure (2203) is less than the first (2564); and the same holds for Bath, 1950 this year, as against 2802 in 1864. The former Bath meeting had no doubt exceptional attractions in the visit of Livingstone, &c. The earlier Aberdeen meeting was presided over by the Prince Consort.

Of the total number, something like one-half are usually associates for the year (paying £1), the others annual or life members, ladies, and foreigners. These groups do not call for special remark here; but we have given a curve of ladies' attendance, as there is room for it, and it is somewhat curious. It seems to have a